It is to be noted that N_{PA} (transitional polar Atlantic) air is flowing around the LOW center from the northeast and north, with the warm tropical Atlantic (T_A) air occupying most of the hurricane.

The vertical cross section through the atmosphere from Omaha eastward through several aerological stations (given in fig. 2) shows that along the Atlantic coast the two very distinct air masses, N_{PA} and T_A, were present. The airplane observation at Washington on that date indicated a relatively cold, moist current from the north which is identified as of polar Atlantic origin, and an unusually warm and moist air mass above which fits almost perfectly the qualitative and quantitative definitions of tropical Atlantic air. A pilot balloon observation at Washington earlier in the night further verified this analysis by showing that the latter current was coming from the east out of the region of tropical air designated on the surface chart, figure 1. The conditions indicated on the cross section to the east of Washington are extrapolated from the data of Mitchel Field, near New York, which is to the east but slightly to the north of the line of aerological stations chosen. If this extrapolation be correct, then Washington was to the west of the crest of the N_{PA} air, and therefore the T_A air above must have been moving downslope. This would then account for the absence of rain at Washington. Upward movement of the T_A probably was to be found only along the immediate coast and at sea.

With this air-mass structure in mind, a possible explanation can be seen for the peculiar rain distribution at Miami when the storm reached there; the absence of rain in appreciable amounts on the forward or western side of the center was particularly noted. It seems reasonable that the current of air of polar origin, which at Washington and New York was 1 to 2 kilometers in depth and probably deepening, played an important part, and that the hurricane, even when it reached Miami, did not consist entirely of tropical air. It also is reasonable to assume that the air of polar origin would occupy the zone of northerly winds on the westward and forward side of the center as it approached Miami. The inherent low moisture content of this air as compared with the normal hurricane air probably accounts in some measure for the peculiar rain distribution noted at that station.

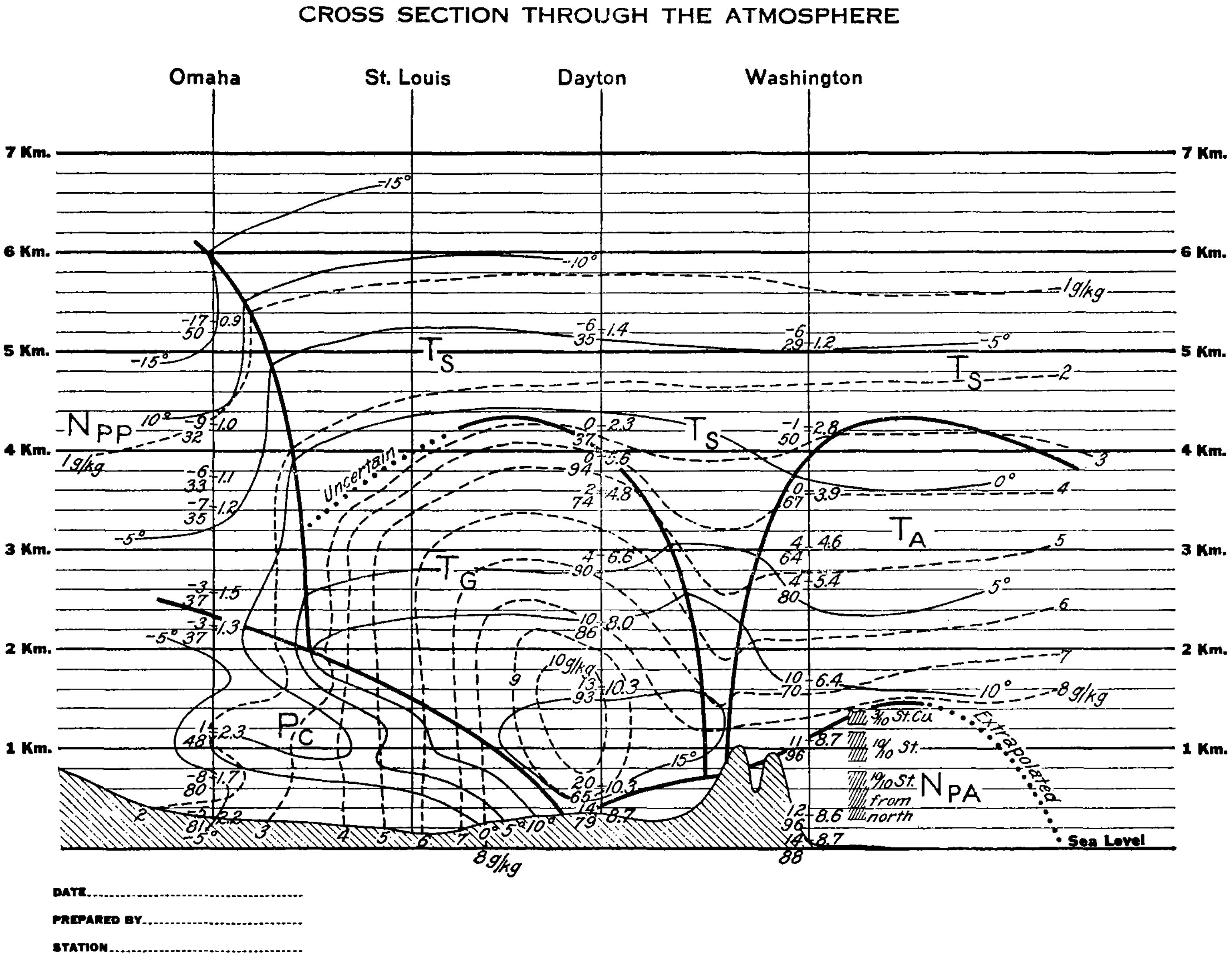

FIGURE 2.—Cross section of the atmosphere, Omaha to Washington, November 1, 1935. Figures to left of vertical lines are temperature and relative humidity (in that order) at the significant levels; figures to right are specific humidity.

The effect of the very dry tropical superior (T_S) air which was occupying much of the upper atmosphere over the eastern United States may also account for the relative lack of precipitation. This air was moving from

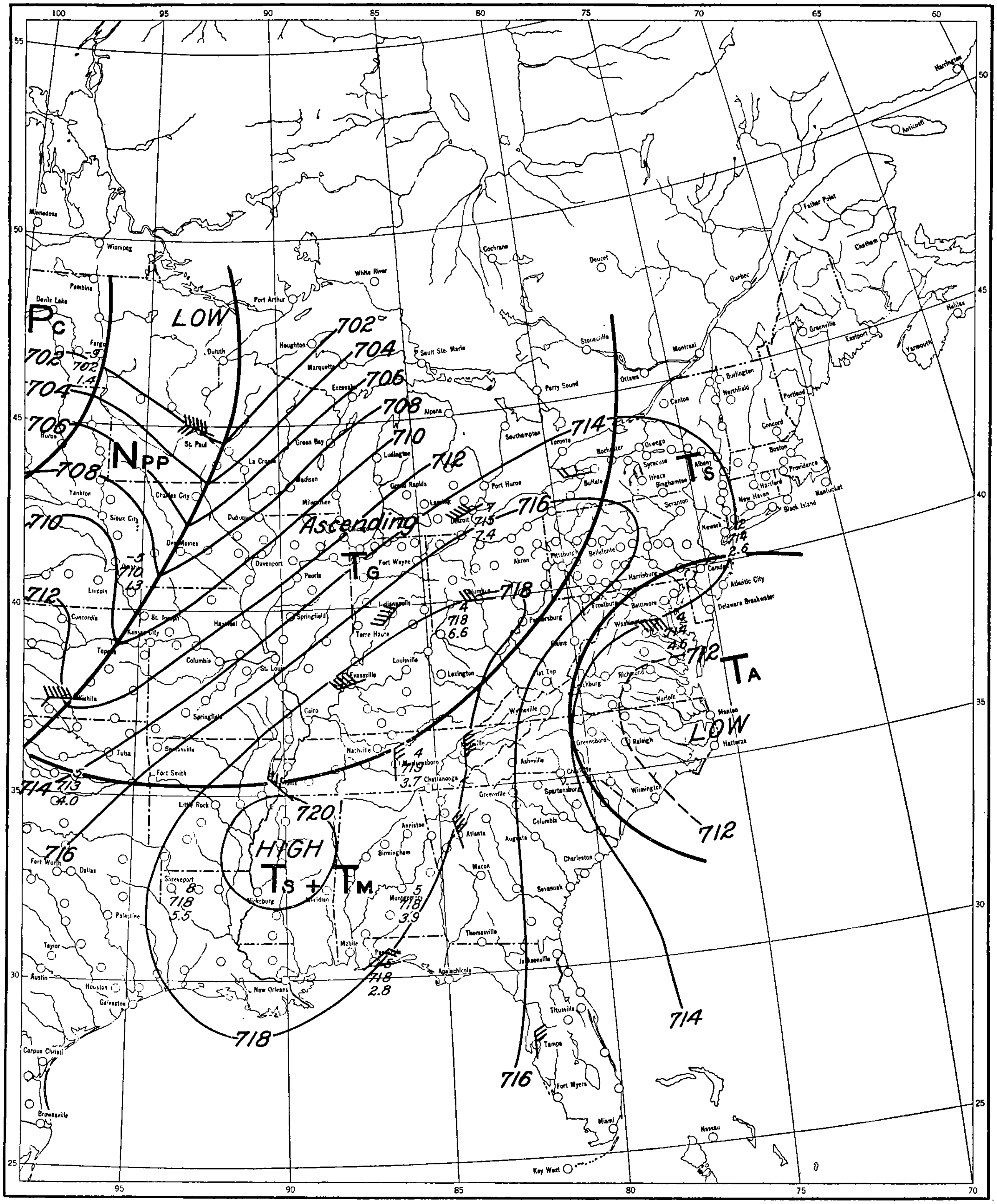

FIGURE 3.—Weather map, 3,000-meter level, November 1, 1935.

the north toward Miami during most of the time. When the storm was many miles at sea on November 1, an easterly current of moist air cut into the T_S over Washington, but at Miami it appears that even when the storm was about to strike, no easterly current aloft was noted. Speaking of the storm during its movement from the Bahamas to Miami, G. E. Dunn, of the Weather Bureau Office at Jacksonville, Fla., writes: "The upper air currents over Florida strengthened somewhat and veered from north-northwest or north to north or north-northeast. At 7 a. m. on November 4, 7 hours before the center reached Miami, the cirrus were still from the north at that place. At 1 p. m. when the center was close to Miami, cirrus still were moving from the north at Key West, but at 2 p. m. had shifted to northeast."

It seems, then, from the observational evidence, that the extra-tropical characteristics of the storm were caused by the importation of other than tropical maritime air masses into the circulation, which is a peculiarity usually found only in extratropical cyclones.

The change in path.—In order to explain in some measure the conditions associated with and perhaps causing the change in direction of movement between the 1st and 2d, it is necessary to examine more closely the air mass and upper air data in figures 1 and 2. Carrying the study a step farther, the observations at all aerological stations in the eastern half of the United States, together with pilot balloon observations, were used to construct a weather map for the 3,000-meter level on November 1. This map is shown in figure 3. The most striking feature of the map is the high pressure centered over the eastern part of the country, with associated northerly winds. Except for the easterly current of tropical Atlantic air over Washington, northerly winds prevailed also at levels below this height, a fact substantiated by pilot balloon observations from a large number of stations which did not reach the 3,000-meter level. A study of pressures at other altitudes shows that the strength of this upper-air anticyclone increased with height.

By considering the temperatures at upper levels, and applying the laws for the static pressure, it is evident that the increasing relatively high pressure with increased height can be definitely associated with the abnormal warmth of the free air. This warm air, as indicated in the analysis, was of tropical Gulf (T_G) origin, and was rising vertically and spreading out over the relatively shallow cold polar masses which occupied most of the surface area. Above this warm, moist current was an even warmer, yet much drier tropical superior (T_S) air mass. This further accentuated the high temperature condition with its resultant slowly decreasing pressure with height. (At New York the T_S air appears colder than the T_A air at Washington, but this has been discounted in view of an error in the recording at the former station which during that period showed temperatures in some cases as much as 5° too low.)

It has already been pointed out that the surface air along the Atlantic coast was moving from the north. A study of the upper-air weather map shows that aloft an even greater north-to-south movement was present. To what extent this prevailed over the sea cannot be determined. However, the indications are that as the hurricane advanced near the continent it gradually came under the influence of this great north-to-south transport which caused the curvature to the left beginning on November 1. Such a conclusion, of course, presupposes that the path of the tropical hurricane is determined by the mean direction of the wind up to 3 to 5 kilometers. By application of this upper-air weather map it might have been possible to forecast earlier the curvature of path.

The second change in course, that from south-southwest to west-southwest, is more difficult to explain. Insufficient data from the upper air preclude a definite discussion of the conditions accompanying this shift. In his report, Dunn states: "However, the slight veering of the winds in the 24 hours prior to the arrival of the storm center [at Miami] may be considered as slightly permissive but not especially indicative of the change in direction which took place."

The weakening in the Gulf of Mexico.—When the center passed into the Gulf of Mexico it began to come in contact with some very dry air which, as shown by the airplane sounding at Pensacola, Fla., on the 5th, was present from 1,500 meters upward. This air came from the west, probably having slowly settled, accompanied by dynamic heating and drying, in the stationary anticyclonic area over the Pacific. R. A. Dyke, meteorologist of the Weather Bureau at New Orleans, has investigated winds aloft in the vicinity of the Gulf of Mexico during this period. He found at high levels a definite current from the west. This was undoubtedly the dry air just mentioned. He remarks: "* * * the westerly winds prevailing at high levels became successively lower in elevation of their lowest limit until an eastward drift prevailed at all elevations recorded on the evening of the 7th." Since the tropical hurricane depends for its energy on the release of the heat carried latent in the water vapor of the air circulating around it, the mixing with this drier air from the west apparently robbed it of its main source of energy.